

CLAIMS

1    1. Apparatus having a probe for interacting with a surface of a sample, wherein the  
2    apparatus comprises:

3                 a Z actuator assembly having first and second extendable and retractable  
4    members, wherein the probe is attached to and moved by the first member;  
5                 the second member oriented and arranged on the Z actuator assembly with respect  
6    to the first member to synchronously move in a direction opposite that of movement of  
7    the first member such that a net momentum of the Z actuator is substantially zero upon  
8    actuation of the first and second members.

1    2. The apparatus as defined in claim 1, wherein the first and second members comprise  
2    piezo actuators.

1    3. The apparatus as defined in claim 2, wherein the piezo actuators comprise one of  
2    piezoelectric tubes, piezoelectric stacks, and piezoelectric bimorphs.

1    4. The apparatus as defined in claim 1, wherein the first and second member comprise one  
2    of voice coil actuators, electrostatic actuator, electrostrictive actuator, or magnetostrictive  
3    actuators.

1    5.    The apparatus as defined in claim 1, further comprising a common central support, the  
2    first and second members being supported on opposite sides of the common central support.

1    6.    The apparatus as defined in claim 1, further comprising a probe mount, the probe mount  
2    being carried by the first member.

1    7.    The apparatus as defined in claim 6, further comprising a counterbalance, the  
2    counterbalance being carried by the second member.

1    8.    The apparatus as defined in claim 7, wherein the probe mount and the first member  
2    together have a momentum substantially the same as a momentum of the counterbalance and the  
3    second member together.

1    9.    The apparatus as defined in claim 8, wherein a mass of the first member and the probe  
2    mount is substantially the same as a mass of the second member and the counterbalance.

1    10.   The apparatus as defined in claim 8, wherein a mass of the first member and the probe  
2    mount is not the same as a mass of the second member and the counterbalance.

1    11.   Apparatus for measuring a surface of a sample, the apparatus comprising:  
2              a scanning member having an X actuator, a Y actuator, and a Z actuator; and

3               opposed first and second members mounted on the Z actuator, each of which is  
4               extendable and retractable in the Z direction, wherein the second member is operated to  
5               balance a momentum of the first member when the first member is extended and  
6               retracted.

1     12.   The apparatus as defined in claim 11, further comprising a probe mount mounted on the  
2               first member, the probe mount mounting a cantilever probe.

1     13.   The apparatus as defined in claim 11, wherein the X, Y, and Z actuators comprise one of  
2               a scanning tube and a scanning flexure.

1     14.   The apparatus as defined in claim 12, further including a counterbalance mounted on the  
2               second member.

1     15.   The apparatus as defined in claim 14, wherein the momentum of the first member and the  
2               probe mount together is substantially equal to the momentum of the second member and  
3               counterbalance together.

1     16.   The apparatus as defined in claim 14, wherein the mass of the first member and the probe  
2               mount together is substantially equal to the mass of the second member and counterbalance  
3               together.

1 17. The apparatus as defined in claim 16, wherein the mass of the first member and the probe  
2 mount together is not the same as the mass of the second member and counterbalance together.

1 18. Apparatus having an actuator for characterizing a surface of a sample with a probe, the  
2 actuator being extensible and retractable in a direction either toward or away from the surface,  
3 the apparatus comprising:

4           a common central support carried by the actuator;

5           a first member carried by the common central support and having a distal end  
6 which is extensible and retractable in a direction either toward or away from the surface;

7           a second member carried by the common central support and having a distal end  
8 which is extensible and retractable in a direction either toward or away from the surface,  
9 wherein the distal ends of the first and second members substantially synchronously  
10 either both extend or both retract.

1 19. The apparatus as defined in claim 18, wherein the first and second members comprise  
2 piezo actuators.

1 20. The apparatus as defined in claim 19, wherein the piezo actuators comprise one of  
2 piezoelectric tubes, piezoelectric stacks, and piezoelectric bimorphs.

1       21. The apparatus as defined in claim 18, wherein the first and second member comprise one  
2       of voice coil actuators, electrostatic actuator, electrostrictive actuator, or magnetostrictive  
3       actuators.

1       22. The apparatus as defined in claim 18, further comprising a mount assembly carried by the  
2       distal end of the first member, wherein the mount assembly comprises (i) a probe mount and (ii)  
3       a cantilever probe having a fixed end carried by the mount and including a stylus spaced from  
4       the fixed end and disposed toward the sample; and further comprising a counterbalance carried  
5       by the distal end of the second member.

1       23. The apparatus as defined in claim 22, wherein a momentum of the first member and the  
2       mount assembly together is substantially the same as a momentum of the second member and  
3       counterbalance together.

1       24. The apparatus of claim 22, further comprising a base connected to the actuator, the  
2       common central support connected to the base and wherein the common central support is  
3       electrically non-conducting, wherein the actuator is hollow and elongated, has an end portion,  
4       and includes a plurality of pins extending away from the end portion thereof, and wherein the  
5       base defines a corresponding plurality of apertures dimensioned for receiving the pins and  
6       operatively connecting the actuator and the base.

1 25. A method of reducing parasitic oscillations in an apparatus having a fast Z actuator  
2 coupled to a slow Z actuator, the fast Z actuator moving a probe which interacts with the surface  
3 of a sample, the method comprising the steps of:

4 balancing a momentum of the fast Z actuator, the momentum being generated  
5 when the fast Z actuator moves the probe relative to the surface, with an equal and  
6 opposite momentum synchronously generated in the fast Z actuator.

1 26. The method as defined in claim 25, wherein the equal and opposite momentum is  
2 generated by moving a mass equal to the mass of the fast Z actuator at a velocity equal to the  
3 velocity of the fast Z actuator.

1 27. The method as defined in claim 25, wherein the equal and opposite momentum is  
2 generated by moving a mass equal to  $1/X$  times the mass of the fast Z actuator at a velocity equal  
3 to  $X$  times the velocity of the fast Z actuator.